

A new species of *Simulium* (*Gomphostilbia*) (Diptera: Simuliidae) from Palawan Island, the Philippines

Hiroyuki TAKAOKA¹⁾ and Victor F. TENEDERO²⁾

¹⁾ Department of Infectious Disease Control, Faculty of Medicine,
Oita University, Hasama, Yufu City, Oita, 879-5593 Japan

²⁾ West Ayala Condominium, 252 Sen. Gill. Puyat Ave., Makati,
Metro Manila, 1,200 Philippines

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Abstract: *Simulium* (*Gomphostilbia*) *binuanense* sp. nov. is described from females and pupae collected from Palawan Island, the Philippines. This new species is characterized in the female by the bare subcosta and the almost bare frons, and in the pupa by the arrangement of the eight pupal gill filaments of which the inner filament of the ventral pair is the longest and thickest of all. This new species is very similar to *S. (G.) pegalanense* from Sabah, Malaysia but barely distinguished by the female frons and pupal terminal hooks.

Key words: black fly, Simuliidae, Palawan, Philippines, taxonomy

We investigated the pupae and larvae of black flies in Palawan Island, the Philippines in 2007 and added three more species to the simuliid fauna of the island totaling 19 species (Takaoka and Tenedero, 2007). One more species of *Simulium* (*Gomphostilbia*) was collected in the same investigation but not included in the previous paper because of the insufficient comparison with the related known species. The pupa of this species is almost indistinguishable from that of *S. (G.) pegalanense* Smart and Clifford described from the reared male, pupae and mature larvae collected from Sabah (Smart and Clifford, 1969), except by the shape of the terminal hooks, as compared with the slide-mounted pupal paratype specimen of *S. (G.) pegalanense* loaned from The Natural History Museum, London. The female of this species is also similar to that of *S. (G.) pegalanense* when compared with the female specimen reared from a pupa of *S. (G.) pegalanense* recently collected near the type locality in Sabah by one of us (HT). The difference in the shape of the terminal

hooks was confirmed by examining the newly collected pupal specimen of *S. (G.) pegalanense*.

In this paper, this new species is described, based on the female and pupal specimens.

The terms for morphological features used here follow those of Takaoka (2003). Type specimens of the new species are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

Simulium (*Gomphostilbia*) *binuanense* sp. nov.

DESCRIPTION. Female. Body length 2.0 mm. **Head.** Nearly as wide as width of thorax. Frons (Fig. 1A) brownish-black, shiny, bare except several simple medium-long hairs along each lateral margin; frontal ratio 1.60–1.66:1.00:2.32–2.63; frons-head ratio 1.00:4.88–5.40. Fronto-ocular area (Fig. 1B) well developed, narrow, directed dorsolaterally. Clypeus brownish-black, thinly grayish-white pruinose, slightly shiny when illuminated at certain

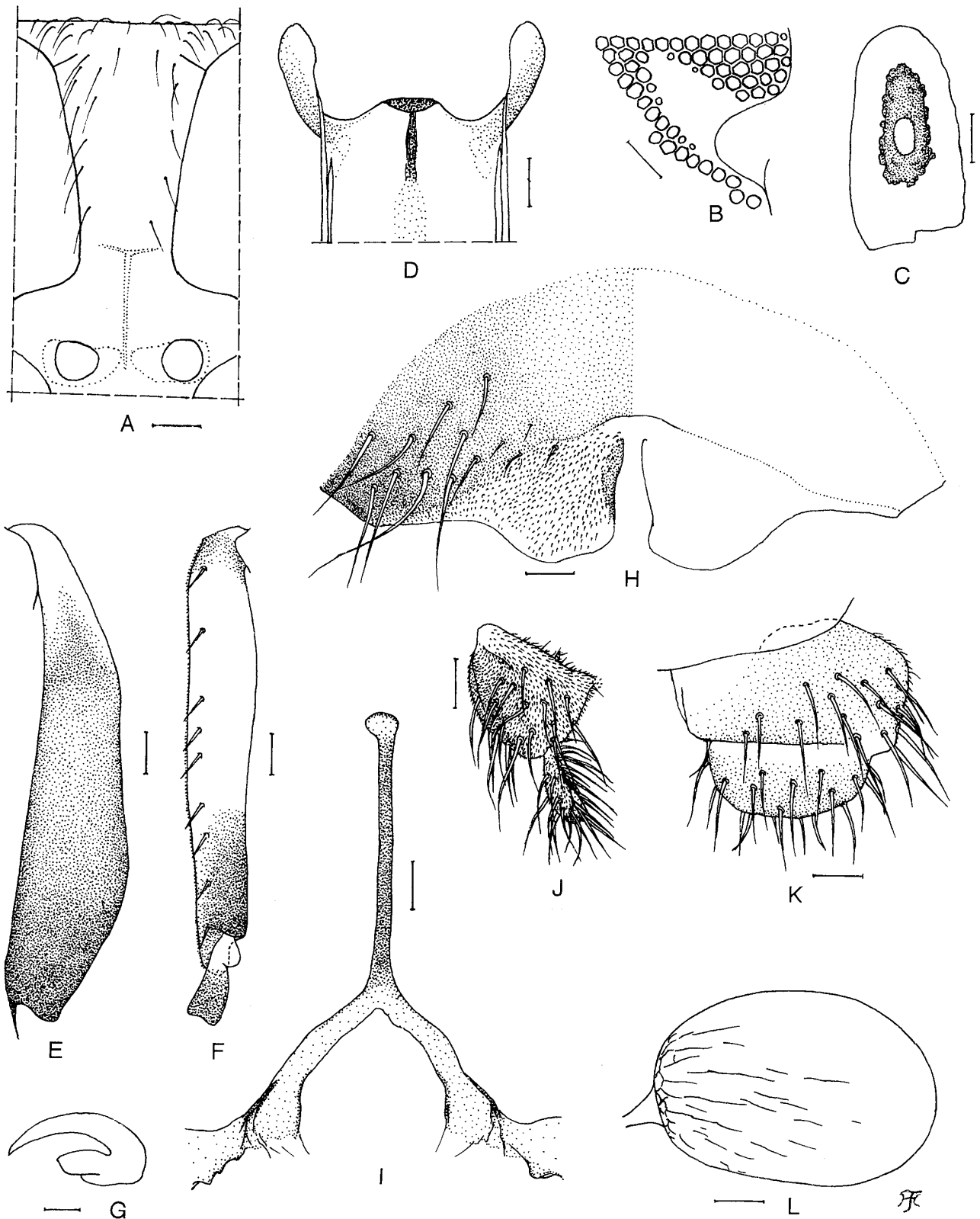
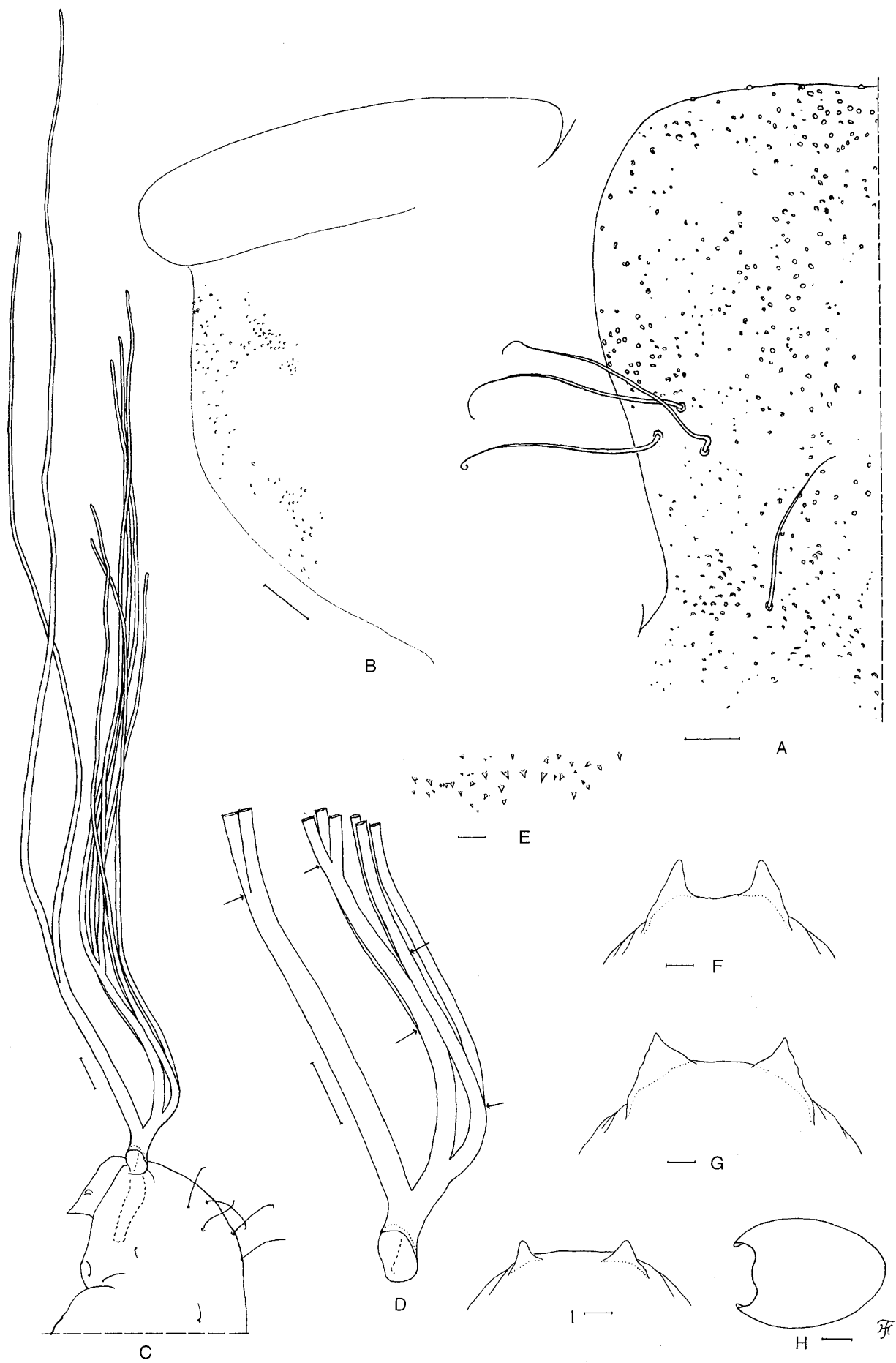


Fig. 1. Female of *Simulium* (*Gomphostilbia*) *binuanense* sp. nov. A, frons (front view); B, fronto-ocular area (right side); C, 3rd segment of maxillary palp with sensory vesicle (right side and front view); D, cibarium; E, hind tibia (left side and outer view); F, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side and outer view); G, claw; H, 8th sternite and ovipositor valves *in situ* (ventral view); I, genital fork (ventral view); J and K, paraprocts and cerci *in situ* (right side; J, ventral view; K, lateral view); L, spermatheca. Scale bars. 0.04 mm for A, B and D-F; 0.02 mm for C and H-L; 0.01 mm for G.

angle of light, moderately covered with yellowish-white scale-like recumbent short hairs interspersed with several dark longer hairs near each lateral margin. Labrum 0.56–0.60 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown to brownish-black except scape, pedicel, and basal 1/2 or a little more of 1st flagellomere whitish-yellow when viewed posteriorly (1st flagellomere almost entirely yellowish when viewed anteriorly). Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:1.11–1.13:2.59–2.71; 3rd segment (Fig. 1C) swollen; sensory vesicle (Fig. 1C) large and oblong, 0.56 times as long as 3rd segment, with medium-sized opening sub-medially. Maxillary lacinia with 11 or 12 inner teeth and 12 or 13 outer ones. Mandible with 20 inner teeth and 9 or 10 outer ones. Cibarium (Fig. 1D) medially forming round sclerotized plate folded forward from posterior margin, and with moderately sclerotized medial longitudinal ridge. **Thorax.** Scutum brownish-black (except anterior calli dark brown), shiny, thinly grayish-white pruinose, moderately covered with yellow scale-like recumbent hairs as well as dark brown similar hairs. Scutellum brownish-black, covered with dark brown short hairs as well as dark brown long upright hairs along posterior margin. Postnotum brownish-black, thinly grayish-white pruinose when illuminated at certain angle of light, and bare. Pleural membrane bare. Katepisternum dark brown, longer than deep, slightly shiny when illuminated at certain angle of light, moderately covered with dark hairs. **Legs.** Foreleg: coxa whitish-yellow; trochanter whitish-yellow with posterior surface light brown; femur light brown with apical cap medium brown (though inner surface whitish-yellow on basal 1/2 or more); tibia whitish on basal 2/3 though posterior surface and small subbasal area of inner surface appearing to be somewhat darkened, and dark brown on apical 1/3; tibia moderately covered with whitish-yellow fine hairs (shiny when illuminated at certain angle of light) on outer surface of basal 3/4; tarsus dark brown to brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 4.7–5.3 times as long as its greatest width. Midleg: coxa dark brown; trochanter light brown with base yellow; femur light brown with apical cap medium

brown; tibia yellow on base, then dark yellow or light brown to medium brown (gradually darkened toward apex) with posterior surface and subbasal small area on both side somewhat darkened, and medium to dark brown on apical cap; tibia moderately covered with whitish-yellow fine hairs (shiny when illuminated at certain angle of light) on more than basal 1/2; tarsus dark brown except basal 3/5 whitish-yellow. Hind leg: coxa light brown; trochanter whitish-yellow; femur light to medium brown with base whitish-yellow and apical cap dark brown; tibia (Fig. 1E) light to medium brown except base yellow and apical cap dark brown; tibia densely covered with white fine hairs (shiny when illuminated at certain angle of light) on posterior and outer surface of basal 2/3; tarsus dark brown except basal 2/3 of basitarsus (though base dark brown) and basal 1/2 of 2nd tarsal segment yellowish-white; basitarsus (Fig. 1F) narrow, nearly parallel-sided on basal 1/2, then slightly narrowed toward apex, 5.91–6.09 times as long as wide, and 0.64–0.66 and 0.58 times as wide as greatest widths of tibia and femur, respectively; calcipala slightly longer than its basal width, and 0.52 times as wide as greatest width of basitarsus; pedisulcus well developed. Claw (Fig. 1G) with large basal tooth 0.51–0.55 times as long as claw. **Wing.** Length 1.5 mm. Costa with brownish-black spinules and hairs with patch of yellow hairs subbasally. Subcosta bare. Hair tuft on stem vein brownish-black. Basal portion of radius with brownish-black hairs; R_1 with brownish-black spinules and hairs; R_2 with brownish-black hairs only. Basal cell absent. **Abdomen.** Basal scale medium brown, with fringe of whitish-yellow hairs (though basal portion of hairs dark). Dorsal surface of abdomen medium to dark brown except basal 3/5 of segment 2 pale yellow, moderately covered with dark short to long hairs; tergites of segments 2 and 6–9 wide and shiny, while those of segments 3–5 narrow, nearly quadrate, subequal in shape and size to one another, and all dull; ventral surface of segment 2 mostly pale yellow, and those of other segments medium to dark brown; sternal plate on segment 7 undeveloped. **Genitalia.** Sternite 8 (Fig. 1H) bare medially, with 8–10 medium-long to long hairs together with a few short slender hairs on each side. Ovipositor valves (Fig. 1H) tongue-like, thin, membranous, moderately covered with microsetae, and with



1 short seta on each side; inner margins slightly sinuous or concave, moderately sclerotized, and moderately separated from each other. Genital fork (Fig. 1I) of usual inverted-Y form, with stem strongly sclerotized having flat, round apex; arm of moderate width, moderately folded medially and with no projection directed posteromedially. Paraproct in ventral view (Fig. 1J) nearly triangular, pointed medially, and with about 3 or 4 sensilla on anteromedial surface; paraproct in lateral view (Fig. 1K) somewhat produced ventrally, 1.7 times as wide as its length, with 18–20 medium-long to long hairs on ventral and lateral surfaces. Cercus in lateral view (Fig. 1K) short, rounded posteriorly, 0.46 times as long as wide. Spermatheca (Fig. 1L) ellipsoidal, 1.45 times as long as wide, well sclerotized except duct and small area near juncture with duct, and with many fissures on surface; internal setae absent; both accessory ducts slender, subequal in diameter to major one.

Pupa. Body length 2.3 mm. **Head.** Integument pale yellow, moderately covered with small flat tubercles of various sizes on frons (Fig. 2A), very sparsely covered with minute tubercles on narrow area of each lateral surface (Fig. 2B), but bare on antennal sheath and most of facial surface; antennal sheath without any protuberances; frons with 3 pairs of simple very long trichomes with coiled or uncoiled apex; 3 frontal trichomes on each side arising close together, subequal in length to one another (Fig. 2A); face with pair of simple long trichomes with uncoiled apex (Fig. 2A), slightly shorter than frontal ones. Gill (Fig. 2C, D) composed of 8 slender thread-like filaments, much longer than pupal body, arranged in $[(1+2)+(1+2)]+2$ filaments from dorsal to ventral, with somewhat swollen transparent organ ventrally (mostly broken); upper and middle triplets sharing short stalk arising from short common basal stalk; upper triplet composed of 1 individual and 2 paired filaments with short to medium-long stalk, middle triplet composed of

1 individual and 2 paired filaments with medium-long stalk; stalk of ventral paired filaments long, slightly thinner than interspiracular trunk, slightly thicker than primary stalk of middle triplet, which is slightly thicker than that of dorsal triplet; stalk of upper triplet lying against that of lower pair at angle of 60 degrees when viewed laterally; all filaments light yellow, gradually tapered toward tips, slightly different in length and thickness from one another: i.e., inner filament of ventral pair longest (3.4 mm) and thickest of all, followed by outer filament (2.8–3.0 mm long) of ventral pair, which is slightly thinner (i.e., 0.86 times as thick as its counter inner filament), filaments of dorsal triplet shortest (1.8–2.0 mm), those of middle triplet intermediate in length (2.4–2.6 mm), and filaments of upper triplet subequal in thickness to one another, 0.66 times as thick as inner filament of ventral pair; filaments of middle triplet also subequal in thickness and very slightly thicker than those of upper triplet; cuticle of all filaments with well developed annular ridges and furrows, densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 pale yellow, untuberculate, with 1 simple slender medium-long hair-like seta on each side; segment 2 pale yellow, untuberculate, with 1 simple slender medium-long hair-like seta and 5 very short setae, submedially on each side; segments 3 and 4 mostly transparent, each with 4 hooked spines and 1 very short seta on each side; segment 5 lacking dorsal spine-combs; segments 6–9 each with spine-combs in transverse row [though spine-combs (Fig. 2E) on segment 9 much smaller in size than those on other segments], together with comb-like groups of minute spines on each side; segment 9 with pair of distinct flat plate-like terminal hooks slightly extending laterally at base and having smooth or undulate outer margin (Fig. 2F, G). Ventrally, segment 4 with 1 slender short hooklet and a few simple slender very short setae on each side; segment 5 with pair of bifid hooks submedially

Fig. 2. Pupa of *Simulium (Gomphostilbia) binuanense* sp. nov. A, frons and portion of face (right half); B, lateral part of face (right side); C, gill filaments and anterior part of thoracic integument (left side and outer view), D, basal 1/4 of gill filaments (left side and outer view; arrows showing branching points); E, spine-combs and comb-like groups of minute spines on dorsal surface of abdominal segment 9 (left half and dorsal view); F and G, terminal hooks (end view; F, paratype female pupal exuviae; G, holotype female pupal exuviae); H, cocoon (dorsal view); I, terminal hooks of *S. (G.) pegalanense* collected by HT (end view). Scale bars. 0.5 mm for H; 0.1 mm for C and D; 0.04 mm for A and B; 0.01 mm for E–G and I.

and a few very short simple slender setae on each side; segments 6 and 7 each with pair of bifid or trifid inner and simple outer hooks somewhat spaced from each other and a few very short simple slender setae on each side; segments 4–8 with comb-like groups of minute spines. Each side of segment 9 with 3 grapple-like hooklets. **Cocoon** (Fig. 2H). Wall-pocket-shaped, thinly and neatly woven, extending ventrolaterally; anterior margin thickly woven, with or without anterodorsal bulge; posterior 1/2 with floor moderately woven; individual threads visible or not; 2.6 mm long by 1.8–2.0 mm wide.

Male and Mature larva. Unknown.

TYPE SPECIMENS. Holotype female (with its associated pupal exuviae and cocoon), reared from a pupa collected from a small stream (width 2 m, stream bed sand, water temperature 24°C, exposed to sun, altitude 40 m), just downstream of the Binuan Bridge at the diverging point to Montible from the main road from Puerto Princesa to Brooks Point, 28. I. 2007, by H. Takaoka and V. F. Tenedero. Paratype: 1 female (with its associated pupal exuviae and cocoon), same data as those of holotype.

SPECIMENS OF RELATED SPECIES USED FOR COMPARISON. Paratype pupal exuviae of *S. (G.) pengalanense* Smart and Clifford, 1969 (BMNH), slide-mounted, collected from a tributary of Pegalan River, crossed by Tenom-Keningau road, Keningau, Sabah, 5–7. III. 1964, by J. Smart; 1 female reared from a pupa collected from a small stream, Kampung Ulu Senagang, Keningau, Sabah, 9. IX. 2007 by H. Takaoka.

ECOLOGICAL NOTES. The pupae of this new species were collected from leaves of trailing grasses in a slowly flowing small stream; associated species were *S. (G.) alienigenum* Takaoka, *S. (G.) epistum* Delfinado, *S. (G.) mangasepi* Takaoka, *S. (Simulium) latistylum* Takaoka and *S. (Wallacellum) tuyense* Takaoka.

ETYMOLOGY. The species name *binuanense* refers to the name of the bridge, Binuan, located over the stream from where this new species was collected.

REMARKS. According to the keys (Takaoka, 2003), *S. (G.) binuanense* sp. nov. is assigned to either the *batoense* species-group or the *ceyonicum* species-group of the subgenus *Gomphostilbia* by having the antenna with 11 segments, the pleural membrane bare, and the claw with large basal tooth (Fig. 1G) in the female, and the eight gill filaments arranged in 3+3+2 filaments (Fig. 2C, D) in the pupa. The close relationship to *S. (G.) pegalanense* strongly suggests that *S. (G.) binuanense* sp. nov. is also classified in the *batoense* species-group though the male of this new species is not available.

The female of *S. (G.) binuanense* sp. nov. is very distinctive within the subgenus *Gomphostilbia* by having the two characteristics: 1) the bare subcosta, a character never before found in all the known *Gomphostilbia* species, and 2) the shiny, almost bare frons, which has been reported in two species [*S. (G.) tahanense* Takaoka and Davies and *S. (G.) sextuplum* Takaoka and Davies] from Peninsular Malaysia (Takaoka and Davies, 1995) and in five species [*S. (G.) asperum* Takaoka, *S. (G.) bifurcatum* Takaoka, *S. (G.) curvum* Takaoka, *S. (G.) heldsbachense* Smart and Clifford and *S. (G.) kalimeraense* Takaoka] from Halmahera or Irian Jaya of Indonesia (Takaoka, 2003), and in two species [*S. (G.) hiroshii* Takaoka and *S. (G.) sherwoodi* Stone and Maffi] from the Solomon Islands (Takaoka, 1994; Takaoka and Suzuki, 1995). This new species is distinguished from all these known species by the shape of the cibarium as well as the shape of the pupal terminal hooks or the number and arrangement of the pupal gill filaments.

The pupa of this new species is very similar to that of *S. (G.) pegalanense* in many characteristics including the arrangement of the gill filaments (Fig. 2C) but is barely distinguished by the shape of

the terminal hooks in end view, of which the outer margin is about twice as long as the inner margin (Fig. 2F, G) in this new species but is nearly as long as or a little longer than the inner margin (Fig. 2I) in *S. (G.) pegalanense*. The female of *S. (G.) pegalanense* had remained unknown, but one female specimen reared from a pupa recently collected near the type locality in Sabah by HT (unpublished data) is very similar to that of *S. (G.) binuanense* sp. nov. in many characteristics including the two rare characteristics mentioned above. The only different characteristics so far found in the female of *S. (G.) pegalanense* was the frons with 10 hairs just above the antennal bases as well as several hairs along each lateral margin (cf., no hairs just above the antennal bases in *S. (G.) binuanense* sp. nov., Fig. 1A).

This new species is also similar to *S. (G.) bataksense* and *S. (G.) babuyanense*, both described from Palawan Island (Takaoka and Tenedero, 2007) by having a similar arrangement of the pupal gill filaments, but is distinguished from the former by the shorter length of the gill filaments, and from the latter in the pupa by the shape of the terminal hooks and in the female by the almost bare frons, the bare subcosta, and darker color of legs.

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